A Hybrid Immersive / Non-Immersive Virtual Environment Workstation

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Introduction

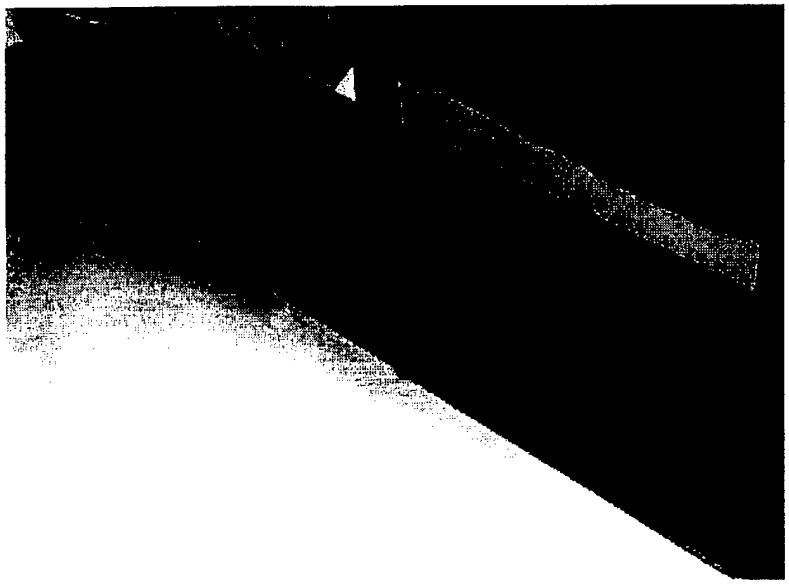
The perception of the images in the Immersive and Non-Immersive systems are based on stereoscopic methods. In the Immersive system, the stereo images form a virtual world in which you are fully immersed. The Non-Immersive system presents the virtual world more like a three dimensional topographical map before you on the table surface. The spatial nature of the database in the Non-Immersive system entices one to reach out and touch, or point at features in the virtual model. To encourage natural interaction with the virtual model, we have experimented with several alternatives and have discovered some techniques which perform well.

Creating More Space

The current table height of the Non-Immersive display has been very deliberately chosen to be at standard countertop height of about 37". This provides a very comfortable setup from an ergonomics point of view when standing at the table. From a visual perspective, this height also helps match the accommodation and convergence cues.

The Non-Immersive display system is based on head-tracked rear projection technology and the objects projected onto the table surface are remarkably three dimensional in appearance. We have found that the depth perception can perhaps be enhanced by creating what appears to be a more volumetric display by raising the perimeter frame of the image surface. Around the projection screen there is a frame which serves to support the projection surface. We have found that raising this border relative to the projection surface creates a greater confidence that there will be a three dimensional object in the volume of space between the perimeter and the image surface.

Conceptual Drawing showing the raised perimeter



Actual Prototype used for experimentation

There is an additional benefit to this configuration also. Physical props which are used to interact with the virtual objects do not come into contact with the display surface. This in turn improves the perceived realism. In order for one to see over the raised perimeter of the display, we introduced a raised platform on the floor in front of the display. This also means that the viewer is proportionally higher relative to the display and is looking at the display surface from a steeper angle. This increases the potential vertical working volume of the display.

New Interface Devices

PushStick - Consistent Navigational Paradigms

The Immersive system uses a navigational paradigm which is unique in that it takes advantage of the axial muscle groups of the user to create an intuitive navigational interface which offers a high degree of control over many orders of magnitude. As discussed in a prior report, this navigation paradigm has been extended to provide analogous control to the user of the Non-Immersive system. The Non-Immersive display system is augmented with a two-handed input device which provides similar functionality to the Immersive display's unique navigational controls.

PushStick in use with the Non-Immersive Display
(Not in stereo mode)

The following sequence of images shows the user navigating from a broad area view of a simulated town down to a single sign post. The navigational interface makes it easy to control one's position on both a macro and micro scale without having to change modes in any way. These images appear distorted because they are calculated for the viewer's actual position. If you hold the page flat and look at the images at an angle of about 30 degrees, they will appear less distorted.

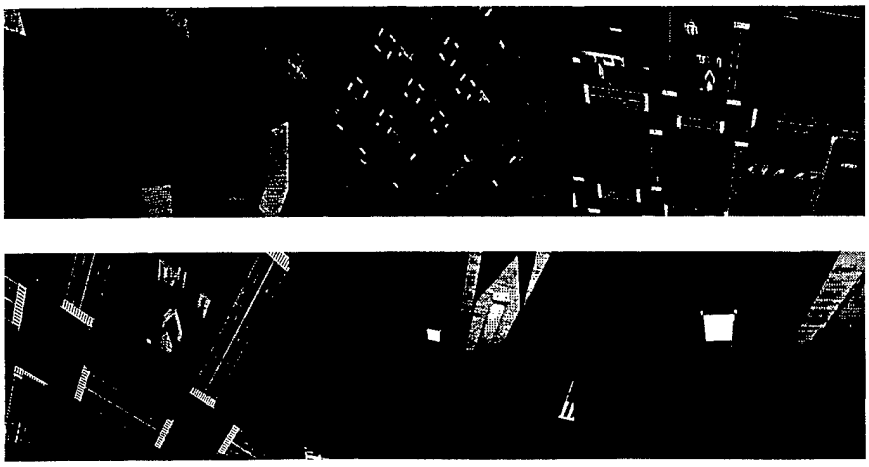


Image Sequence

The Immersive user gets quite a different perspective on this area because they are actually in the virtual environment of the simulated town. The Immersive user sees images such as the one below.

Image as seen by the Immersive User

The Immersive workstation is based on the Push display which provides both high resolution stereo imagery and a navigational input device so the user can move around in the virtual space.

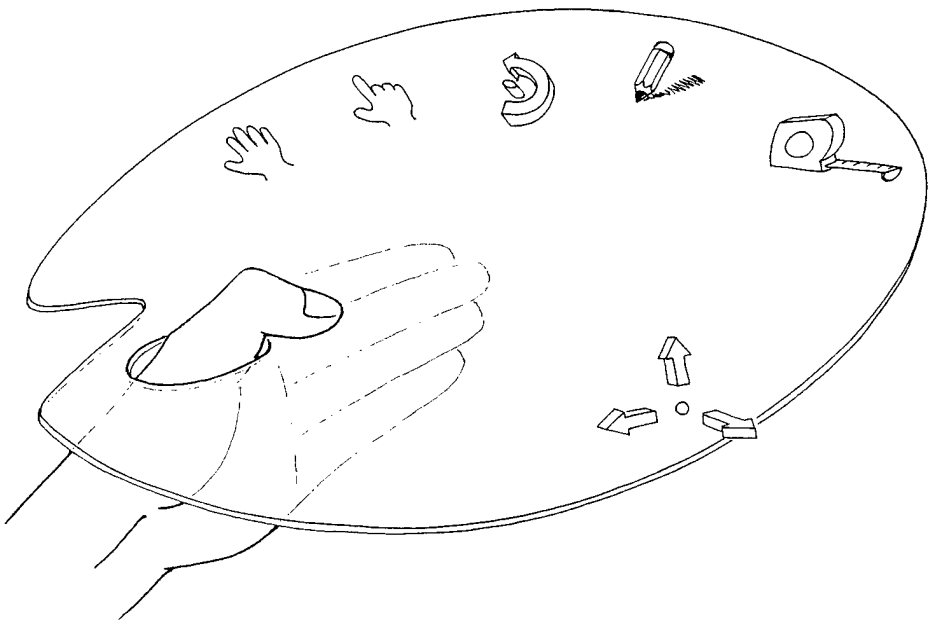
Immersive User

User Interaction Devices

In addition to navigation in the database, the users of the Non-Immersive system will want to reach into the space to query entities and to perform selections of modes and data overlays etc. These interactions break down into two basic forms. Firstly, there are picking, pointing, and selecting items. Secondly, there are tasks with respect to the selection of modes, overlays, and other parameters not necessarily directly related to any particular entity.

The tasks users may wish to perform are going to be specific to a particular type of command and control application but a general interaction framework is needed within which to implement specific interfaces. For example, a user may wish to select a particular ship and find out what its current heading and speed are. Such a request requires two actions - selecting the ship and then identifying what information should be displayed. These two sub-tasks can be performed explicitly or implicitly. In an implicit system, the selection of the ship might elicit a "standard" response which is the display of its current course. Explicit queries may be performed by selecting both the entity and selecting what data to display from a menu. Menus in three dimensional spaces tend to be difficult to use as there is no good physical feedback to guide the user. Often, first time use of such virtual menus is frustrating as one's hand floats near the item one wishes to select and then when the fingers move to make the selection, the hand invariably moves slightly so that no item (or the wrong item) is selected. Many researchers have used particular gestures for performing a variety of actions but remembering more than a small number of gestures is problematic. In order to overcome these deficiencies, we have prototyped a physical prop (which we call a V-palette) which is used to hold the virtual menu. The device is much like an artist's palette. The device is made of a transparent plastic and has a number of transparent conductive areas on it's surface.

The V-palette is held in the user's left hand and selections are made by touching one of the conductive areas on the V-palette with a Pinch glove worn on the right hand. The V-palette is tracked with a tracker so its position and orientation are known to the software application. The computer can thus draw virtual icons in space making them look as if they are actually on the V-palette. Thus, when looking at the V-palette there are several icons floating in space at that location. Touching the V-palette with the other hand triggers the item. We are experimenting with this interaction technique with the hope of creating an interface for virtual menus which is both intuitive, reliable, and easy to use.



V-palette

Conclusion

In conclusion, we have developed an approach based on a rough prototype for making the virtual spaces appear more three dimensional by introducing a raised frame around the Non-Immersive display. This has an additional benefit in that it encourages a wider use of the hands and permits the use of some novel input devices such as the V-palette which we have also roughly prototyped. The navigational metaphor for both the Immersive and Non-Immersive users has been made consistent through the use of the Push technology both in the Desktop Push Immersive Display and in the PushStick used by the Non-Immersive user.